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An Evolution in Medical Physics and Radiotherapy Practice

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Introduction

Despite the advancement of technologies in medical radiation and nuclear to better treat cancerous tumors, I am a pioneer in the creation of a novel method and technology in medical physics and medical radiation both to achieve accurate dosimetry and obtaining the best-required irradiation time in the radiotherapy practice. In this investigation, I carried out much research in the fields of medical physics and medical radiation, and I applied some software and nuclear code, including MATLAB software and the MCNPX code.

Some of the features of this research are as follows:

- Designing a liver phantom taken from real liver tissue for dosimetry purposes.
- Simulation of the phantom and dosimetry of it.
- Accurate dosimetry of real liver tissue for the course of X-ray radiotherapy.
- Comparing the dosimetry results obtained from the liver phantom and the liver tissue to verify the designed phantom.
- Applicability of the phantom for dosimetry of a real liver tissue based on the obtained results.
- Obtaining the required irradiation time for this course.

Methodology

- Extraction of the materials of any organ in the abdominal tissue.
- Decomposing each of the materials in an adult liver tissue including water and some organic compounds into its con-



Figure 1: The full block diagram of the research.

stituent elements based on mass percentage and density of every element.

• Making a correlation between the accurate mass of every decomposed material of human liver tissue with masses of the phantom components.

- Simulation and dosimetry of real liver tissue by DICOM images, MATLAB software, and the MCNPX code.
- Application of the Di-Com images of CT scan belonging to a male's abdominal tissue from YZ direction in the Cartesian coordinates in a way that the front view of the liver appears.
- Recognizing the type of each material based on the level of grayness and Hounsfield Unit scale (HU) of DICOM CT slices.
- Making a large number of volumes as voxel and repeating them to build up the full geometry of tissue.
- Assignment of each radiodensity to that voxel.
- Filling up every voxel completely homogeneous with the existing materials in the abdominal tissue.
- Contouring the liver tissue and separating it in the abdominal tissue.
- Transferring the generated data into the MCNPX code.
- Designing a module based on absorbed dose to obtain the required irradiation time.
- Applicability of this method for every patient through his/ her own CT scan images to determine the admissible absorbed dose.



Figure 3: The equivalent liver phantom simulated by the MCNPX code.



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Figure 4: The data generated by MATLAB programming and transferred to MCNPX code.

Figure 2: (a) The side view of the cylindrical tube path and liver tissue

(b) The schematic view of the equivalent liver phantom.

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Figure 5: (a) The DICOM image of the abdominal region

- (b) The image of the abdominal region converted from DICOM to a new image extracted from MATLAB software
- (c) The abdominal region image converted to a new image extracted from the MCNPX code.



Figure 6: The views of the liver phantom, real liver tissue, and the segmented liver tissue.

- Applicability of the designed liver phantom for dosimetry for the sake of studying photon behavior in materials of liver tissue.
- Feasibility of standardizing the obtained results for similar investigations about liver tissue and determining the required irradiation time to reach the desirable dose for each patient.

uired Irradiation Time	Required Irradiation Time					
rgy (MeV) 2.5	Energy (MeV) 6.7					
ivity (Bq) 5.55e8 (Ci) 1.50E-2	Activity (Bq) 6.4e10 (Ci) 1.73E+0					
uired Dose (Gy) 1.5	Required Dose (Gy) 1.5					
uied Irradiation Time (sec) 1.264E+05	Requied Irradiation Time (sec) 8.381E+02					
Run	Run					

Figure 7: The accurate irradiation time obtained in seconds by the software with respect to the desired treatment dose at different intensities (in Bq) and X-ray photon energies (MeV).

Conclusions

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• A fairly good agreement between the amounts of absorbed doses obtained from the prepared liver phantom and the real liver tissue.

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